International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 7, Issue 2, Apr 2017, 267-272

Original Article

RESPONSE OF WHEAT TO IRRIGATION AND HYDROGEL WITH NUTRIENT MANAGEMENT

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ABSTRACT

The influence of irrigation and nutrient management using hydrogels on the growth and yield of wheat crops was studied by conducting field experiments at the farm at Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The field studies were performed during the rabi season (2012–13) in clayey soil in a factorial randomised blocked design. The experiment had 18 treatment combinations and 3 replications. The role of effective irrigation was also studied by employing 4 different irrigation levels. Among all the irrigation levels, I_3(four times irrigation) recorded the best grain and straw yield, as well as biological yield. However, I_1 (no irrigation) reported the best harvest index by producing a higher grain-to-straw ratio. All the other crop growth characteristics, such as number of spikes in an area, number of spikes per plant, number of grains per plant, grain weight per plant (g), test weight (g), highest gross, net monetary return and B: C ratio, were found to be significantly better in I_3(four times irrigation)than the other irrigation levels (i.e., I_2 with two times irrigation and I_1 with no irrigation). The study of nutrient management using hydrogels and NPK showed that H_3treatment (100 % NPK with 5 kg/ha hydrogel) produced the best output in the crop. Some of the plant characteristics that were studied to determine the plant growth were the following: spikes in an area, number of spikes per plant, number of grains per plant, grain weight and test weight. H_3 treatment showed superior output in all of the aforementioned plant characteristics and registered better grain and straw yield as well as biological yield compared to the treatments H_2 (100 % NPK with 2.5 kg/ha hydrogel) and H_4 (70 % NPK without hydrogel), with H_4 treatments registering the least output.

KEYWORDS: Irrigation, Hydrogel & NPK

Received: Jan 27, 2017; **Accepted:** Feb 21, 2017; **Published:** Mar 10, 2017; **Paper Id.:** IJASRAPR201737

INTRODUCTION

In the agriculture sector, water is usually a scarce resource. Therefore, farmers need to employ farming practices that ensure optimized use of this fundamental plant requirement, which can boost all other production factors. Adequate irrigation results in improved yields per unit area and time. However, to determine the adequate levels, a systematic study on plant–water association, climate, agronomic procedures and economic impact needs to conducted. For wheat cultivation, efficient irrigation is an important criteria because its growing season of October to Aprilis relatively a dry season. Hydrophilic gels or “hydrogels” may be used to improve the quantity of available moisture in the root zone, thus increasing the duration between irrigations. Hydrogels are cross linked polymers that can absorb 400 to 1500 times their dry weight in water(Peterson 2002), thereby acquiring the name

"super absorbents". However, it should be noted that polymers do not reduce the water consumption of the crop. For efficient hydrogel usage, its particle size (powder or granules) must be correlated to the texture of soil, salinity of soil, and presence of ions. Cross-linked polyacrylamides can retain up to 400 times their weight in water, and release 95% of this water, making them suitable hydrogels. The higher the cross linking, the lesser is the water retained. However, the availability of water through hydrogels in influenced by the presence of dissolved salts (effluent water) or fertilizer salts (Wang and Gregg 1989).

MATERIALS AND METHODS

The influence of irrigation and nutrient management using hydrogels on the growth and yield of wheat crops was studied by conducting field experiments at the farm at Wheat Research Unit, Dr. PanjabraoDeshmukhKrishiVidyapeeth, Akola. The field studies were performed during the rabi season (2012–13) in clayey soil with fairly uniform topography in a factorial randomised blocked design. The experiment had 18 treatment combinations and 3 replications. Chemical analysis of the soil showed that the soil was slightly alkaline (pH 8.20). The organic carbon content (0.46%) and available nitrogen content (150.15 kg ha^{-1}) were moderate and low, respectively. The available phosphorus(11.10 kg ha^{-1}) was also low. However, the soil was rich in available potassium(260.21kg ha^{-1}). The first factor studied was the influence of irrigation. Three different irrigation levels were employed in the following fashion: I_1–No irrigation,I_2–Two irrigations at CRI and boot leaf stage, and I_3– Four irrigations at CRI, Tillering, boot leaf stage and milk stages. The next factor considered was nutrient management using 6 combinations of Hydrogel and NPK as follows:H_1– 100% NPK without hydrogel,H_2– 100% NPK with 2.5 kg/ha hydrogel,H_3–100% NPK with 5 kg/ha hydrogel,H_4– 70% NPK without hydrogel,H_5–70% NPK with 2.5 kg/ha hydrogel, and H_6– 70% NPK with 5 kg/ha hydrogel. Wheat variety AKAW-4627 was used in the field studies. The seeds were drilled at 18 cm distance between two rows. Hydrogel in the powder form was added to the soil prior to the treatments.

RESULTS AND DISCUSSIONS

Application @ increased grain yield over without hydrogel treatment in 100 % NPK while hydrogel application @ 2.5 kg/ha and 5 kg/ha increased grain yield over without hydrogel treatment in 100 % NPK. Irrigation significantly influenced grain yield, with I_3 (four times irrigation) producing the highest grain and straw yield (27.24 q ha^{-1}) and I_1 (no irrigation) producing the least grain yield. I_3treatment produced the most number of spikes and grains and also reported a higher test weight (Tables 1 and 2). Inadequate water supply (irrigation) resulted in water stress for the crop. This resulted in reduced number of tillers, fertile spikelets, and grains, as well as grain weight (Karim*et al*., 2000). These findings are in accordance to the data obtained by Jana *et al*. (2001).On applying hydrogel with 100% NPK at the rate of 2.5 kg/ha and 5 kg/ha, the grain yield was respectively 4.66 % and 18.27 % higher compared to the yield without usage of hydrogel. On applying hydrogel with 100% NPK at the rate of 2.5 kg/ha and 5 kg/ha, the grain yield was respectively 8.43 % and 18.85 %higher compared to the yield without usage of hydrogel.

Economics

Efficient irrigation has an impact on the gross and net monetary returns. Better irrigation practices, such as treatment I_3 (i.e., four times irrigation), resulted inconsiderable higher gross monetary returns (50332 ` $ha^{-1}$)in comparison to treatment $I_2$ (two times irrigation) and treatment $I_1$ (no irrigation), which recorded 35682 ` ha^{-1} and 28653 ` ha^{-1} returns, respectively(Table 3). The net monetary returns also followed a similar trend. This scenario was basically because of the

higher grain and biological yield inI_3treatment (four times irrigation) compared to the other treatments. Better nutrient management, such as treatment H_3 (100% NPK with 5 kg/ha hydrogel), resulted in considerably higher gross monetary returns (45984 ` $ha^{-1}$).Treatment $H_4$ (70% NPK without hydrogel) recorded the least gross monetary returns (31594 ` ha^{-1}).The net monetary returns also followed a similar trend.

CONCLUSIONS

Effect of Irrigation

- The yield attributing characters like spike m^{-2}, number of spikes $plant^{-1}$, number of grains $plant^{-1}$, grain weight $plant^{-1}$ test weight (g) recorded significantly superior values for I_3 (four irrigation) over I_2 (two irrigation) and I_1 (no irrigation).
- I_3 (four irrigation) recorded significantly higher grain yield, straw yield and biological yield while in case of harvest index and grain to straw ratio I_1 (no irrigation) obtained higher values.
- The highest gross, net monetary return and B: C ratio was obtained from treatment I_3 (four irrigation) followed by I_2 (Two irrigation).

Effect of Hydrogel

- The yield attributing characters like spikes m^{-2}, number of spikes $plant^{-1}$,number of grains $plant^{-1}$, grain weight $plant^{-1}$ and test weight recorded superior values for treatment H_3 (100 % NPK with 5 kg/ha hydrogel).
- Treatment H_3 (100 % NPK with 5 kg/ha hydrogel) registered significantly higher grain yield, straw yield, biological yield, harvest index and grain to straw ratio followed by treatment H_2 (100 % NPK with 2.5 kg/ha hydrogel) while treatment H_4 (70 % NPK without hydrogel) was inferior among all treatments studied.
- The highest gross monetary return, net monetary return and B: C ratio was obtained from treatment H_3 (100 % NPK with 5 kg/ha hydrogel).

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APPENDICES

Table 1: Grain Yield, Straw Yield, Biological Yield (Q Ha^{-1}), Harvest Index and Grain to Straw Ratio as Influenced by Various Treatments

Treatments	Grain Yield (Q) Ha^{-1}	Straw Yield (Q) Ha^{-1}	Biological Yield (Q) Ha^{-1}	Harvest Index	Grain to Straw Ratio
Factor A – Irrigation					
I_1 - No irrigation	15.66	35.99	52.28	30.03	0.44
I_2 - Two irrigation	19.34	47.43	66.77	29.06	0.41
I_3 - Four irrigation	27.24	67.50	114.64	23.76	0.41
S.E.(m)±	0.58	1.44	1.76	-	-
C.D. at 5%	1.68	4.15	5.09	-	-
Factor B - Hydrogel					
H_1 - 100% NPK without hydrogel	21.23	52.08	80.62	27.70	0.42
H_2 - 100% NPK with 2.5 kg/ha hydrogel	22.22(4.66)*	55.89	84.40	27.30	0.41
H_3 - 100% NPK with 5 kg/ha hydrogel	25.11(18.27)	58.04	89.44	29.00	0.44
H_4 - 70% NPK without hydrogel	17.08	42.63	68.03	25.71	0.40
H_5 - 70% NPK with 2.5 kg/ha hydrogel	18.52(8.43)	44.72	69.29	28.00	0.42
H_6 - 70% NPK with 5 kg/ha hydrogel	20.30(18.85)	48.48	75.59	27.99	0.43
S.E.(m)±	0.82	2.03	2.50	-	-
C.D. at 5%	2.37	5.81	7.20	-	-
Interaction (A x B)					
S.E.(m)±	1.424	3.523	4.321	-	-
C.D. at 5%	NS	NS	NS	-	-
GM	20.74	50.31	77.90	27.62	0.42

Table 2: Number of Spikes $Plant^{-1}$, Number of Grains $Plant^{-1}$, Grain Weight $plant^{-1}$, Straw Weight $Plant^{-1}$ and Test Weight as Influenced by Various Treatments

Treatments	Number of Spikes $Plant^{-1}$	Number of Grains $Plant^{-1}$	Grain Weight $Plant^{-1}$	Straw Weight $Plant^{-1}$	Test Weight (G)
Factor A – Irrigation					
I_1 - No irrigation	1.96	61.12	1.69	3.70	28.59
I_2 - Two irrigation	2.89	110.98	3.50	5.95	31.47
I_3 - Four irrigation	3.29	127.04	4.70	8.60	36.73
S.E.(m)±	0.04	0.33	0.08	0.11	0.21
C.D. at 5%	0.12	0.94	0.22	0.31	0.60
Factor B - Hydrogel					
H_1 - 100% NPK without hydrogel	2.71	99.40	3.46	6.27	32.63
H_2 - 100% NPK with 2.5 kg/ha hydrogel	2.98	101.20	3.55	6.27	32.95
H_3 - 100% NPK with 5 kg/ha hydrogel	3.09	102.07	3.56	6.33	33.45
H_4 - 70% NPK without hydrogel	2.31	97.58	2.79	5.63	30.95
H_5 - 70% NPK with 2.5 kg/ha hydrogel	2.53	98.87	3.09	5.79	31.32
H_6 - 70% NPK with 5 kg/ha hydrogel	2.64	99.18	3.35	6.22	32.30
S.E.(m)±	0.06	0.46	0.11	0.15	0.30
C.D. at 5%	0.17	1.34	0.31	0.44	0.85
Interaction (A x B)					
S.E.(m)±	0.10	0.80	0.18	0.27	0.51
C.D. at 5%	NS	NS	NS	NS	NS
GM	2.71	99.71	3.29	6.08	32.26

Table 3: GMR (` $Ha^{-1}$), NMR (` Ha^{-1}) and B: C Ratio As Influenced by Various Treatments

Treatments	GMR(` Ha^{-1})	NMR (` Ha^{-1})	Cost of Cultivation (` Ha^{-1})	B:C Ratio
Factor A – Irrigation				
I_1 - No irrigation	28653	4061	24592	1.16
I_2 - Two irrigation	35682	9490	26192	1.36
I_3 - Four irrigation	50332	22540	27792	1.81
S.E.(m)±	943	943	-	-
C.D. at 5%	2724	2724.12	-	-
Factor B - Hydrogel				
H_1 - 100% NPK without hydrogel	39191	13064	26127	1.50
H_2 - 100% NPK with 2.5 kg/ha hydrogel	41134	14257	26877	1.53
H_3 - 100% NPK with 5 kg/ha hydrogel	45984	18357	27627	1.66
H_4 - 70% NPK without hydrogel	31594	6837	24757	1.27
H_5 - 70% NPK with 2.5 kg/ha hydrogel	34101	8594	25507	1.33
H_6 - 70% NPK with 5 kg/ha hydrogel	37329	11072	26257	1.42
S.E.(m)±	1334	1334	-	-
C.D. at 5%	3852	3852	-	-
Interaction (A x B)				
S.E.(m)±	2310	2310	-	-
C.D. at 5%	NS	NS	-	-
GM	38222	12030	26192	1.44